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IMAGE PROCESSING METHOD FOR EXTRACTING OBJECT MOVEMENT TRACE

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IMAGE PROCESSING METHOD FOR EXTRACTING OBJECT MOVEMENT TRACE

[Buttai ido kiseki shushutsu no tame no kazo kyori hoho]

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[There are no amendments to this patent.]

Claims

1. An image processing method for determining the movement direction of an object in the image pickup range by processing the consecutive images and by following the object movement trace present in the images, characterized by the following steps of operation:

a first step of operation in which all of the consecutive images in a prescribed time are set side-by-side in time to form a three-dimensional time-space image;

a second step of operation in which the time-space image formed in said first step of operation is cut by plural planes perpendicular to the original consecutive images, and the images appearing on the cross-sections are extracted as cross-sectional images;

a third step of operation in which the slope of the trace of the object appearing in said second step of operation is determined, and the cross-sectional image having the maximum slope at the prescribed time is selected; and a fourth step of operation in which the portion at said time

of the cross-sectional image selected in said third step of operation is extracted, and the portions of the plural cross-sectional images obtained as a result of application of said extracted portion on all of the cross-sectional images within the prescribed time are set side-by-side in time sequence to form a trace cross-sectional image.

2. An image processing method for determining the movement direction of an object in the image pickup range by processing the consecutive images and by following the object movement trace present in the images, characterized by the following steps of operation:

a fifth step of operation in which the consecutive images from a short time are set side-by-side in time sequence to form the time-space image for the short time;

a sixth step of operation in which the time-space image of said short time is cut by plural planes perpendicular to the original consecutive images of said short time, and the images of the short time appearing on the cross-sectional plane are extracted as the cross-sectional images;

a seventh step of operation in which the slope of the object trace appearing on said cross-sectional image is determined, and the cross-sectional image of the short time with the maximum slope at this time is selected; and an eighth step of operation in which the cross-sectional images selected in said seventh step of operation are set side-by-side in time sequence to form a trace cross-sectional image.

3. The image processing method for extracting object movement trace described in Claim 1 or 2, characterized by the fact that in said second and sixth steps of operation, for each of the original consecutive images, after performing edge extraction treatment, theoretical treatment, noise removal treatment and other filter treatment and image processing to extract characteristics, the plural planes perpendicular to the original consecutive images are considered, and the images obtained by projecting said treatment results on said planes are extracted as the cross-sectional images.

4. The image processing method for extracting the object movement trace described in any of Claims 1-3, characterized by the fact that said second-fourth steps of operation and said sixth-eighth steps of operation include a step of operation in which the cross-sectional images are extracted simultaneously when there exist plural objects moving in a single image.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention pertains to an image processing method for extracting an object movement trace. Especially, the present invention pertains to an image processing method for extracting an object movement trace in view-based image recognition.

[0002]

Prior art

As a scheme for the moving picture processing with detection of an object moving in a three-dimensional space, a scheme has been proposed in which a time-space image prepared by setting the consecutive camera images side-by-side in the time axial direction.

[0003]

As an example, Taniguchi et al. published a paper with the title of "Proposal of a scheme for moving picture processing using time-space image – DTT method –," Denshi Joho Tsushin Gakkai Shi, D-II, Vol. J77-D-II, No. 10, pp. 2019-1026, October 1994. In this method, under the condition that the movement direction of the object is nearly constant, the useful data pertaining to the object with respect to each frame are extracted, and the obtained data are projected in the axis (directional axis) parallel to the movement direction of the object so as to form one-dimensional data. Then, by setting the one-dimensional data of the various frames side-by-side in time sequence, the time-space image is converted to a planar image on the plane defined by the directional axis – time axis. For such two-dimensional image, the state of movement of the object is represented as one region, and it is possible to detect the movement of the object by performing simple two-dimensional image processing.

[0004]

Problems to be solved by the invention

However, in this scheme, it is indispensable to have a schematic knowledge on the movement of the object and to set the cutting plane in that direction beforehand. Consequently, although there is no trouble when handling an object moving linearly on the image, it is nevertheless impossible to handle the general object that moves in two dimensions.

[0005]

Consequently, the main objective of the present invention is to provide an image processing method for extracting the object movement trace, characterized by the fact that there is no need to judge the identity of the object with images taken at different times, the precision in following the object trace can be improved, and the resistance to noise improves.

[0006]

Means to solve the problems

The invention in Claim 1 provides an image processing method for extracting an object movement trace, characterized by the fact that in the image processing method for determining

the movement direction of an object in the image pickup range by processing consecutive images and by following the object movement trace present in the images, the operation is performed as follows: all of the consecutive images over a prescribed time are set side-by-side in time to form a three-dimensional time-space image; the time-space image formed in the aforementioned operation is cut by plural planes perpendicular to the original consecutive images, and the images appearing on the cross-sections are extracted as cross-sectional images; the slope of the trace of the object appearing in said operation is determined, and the cross-sectional image with the maximum slope at the prescribed time is selected; and the portion at said time of the cross-sectional image selected in said operation is extracted, and the portions of the plural cross-sectional images obtained as a result of application of said extracted portion on all of the cross-sectional images within the prescribed time are set side-by-side in time sequence to form a trace cross-sectional image.

[0007]

The invention in Claim 2 provides an image processing method similar to that described in Claim 1, and has the following operation: the consecutive images over a short time are set side-by-side in time sequence to form the time-space image of that short time; the time-space image of said short time is cut by plural planes perpendicular to the original consecutive images of said short time, and the images of the short time appearing on the cross-sectional plane are extracted as the cross-sectional images; the slope of the object trace appearing on said cross-sectional images is determined, and the cross-sectional image of the short time with the maximum slope at this time is selected; and the cross-sectional images selected in said operation are set side-by-side in time sequence to form a trace cross-sectional image.

[0008]

The invention described in Claim 3 pertains to the image processing method for extracting object movement trace described in Claim 1 or 2, characterized by the fact that in said operation, for each of the original consecutive images, after performing edge extraction treatment, theoretical treatment, noise removal treatment and other filter treatment and image processing to extract characteristics, the plural planes perpendicular to the original consecutive images are considered, and the images obtained by projecting said treatment results on said planes are extracted as the cross-sectional images.

[0009]

The invention described in Claim 4 is characterized by the fact that the cross-sectional images are extracted simultaneously when there exist plural objects moving in a single image.

[0010]

Embodiment of the invention

Figure 1 is a flow chart illustrating the flow of the overall processing in an application example of the present invention. Figure 2 is a diagram illustrating the state of the consecutive images and movement object. Figure 3 is a diagram illustrating the time-space image. Figure 4 is a diagram illustrating the cross-section of the time-space image taken by a plane parallel to the time axis. Figure 5 is a diagram illustrating the method for preparing the trace cross-sectional image from the plural cross-sectional images.

[0011]

As shown in Figure 1, for example, a camcorder is used to take the consecutive images that are input to an image processor. Then, in step (referred to as SP) SP1 shown in Figure 1, as the images at an instant (11, 12, 13) shown in Figure 2 are represented as $I(x, y)$ with the orthogonal coordinates of X-axis and Y-axis, all of the images obtained are set side-by-side in time sequence. That is, suppose there is a time axis (T-axis) perpendicular to both X-axis and Y-axis, by setting the images along this axis, it is possible to construct the three-dimensional image shown in Figure 3, that is, time-space image $I(x, y; t)$. In step SP2, said time-space image $I(x, y; t)$ is cut by a plane parallel to the time axis, and the image appearing on the cut plane is taken as cross-sectional image $C(d, t; \theta)$. Here, angle θ is the angle formed between the plane parallel to the time axis and the X-axis of the original image, with $\theta = \arctan(y/x)$, and $0 \leq \theta < \pi$. Now, as angle θ is changed, plural cross-sectional images $C(d, t; \theta)$ can be obtained.

[0012]

On said cross-sectional image $C(d, t; \theta)$, a portion of the image of moving object (21) contained in the original consecutive images must appear as the trace. Consequently, in step SP3, slope $\partial d/\partial t$ on the object trace on said cross-sectional image $C(d, t; \theta)$ at a certain time is determined, and it is a function of angle θ, and it reaches maximum at a certain angle $\theta_d(t)$. In step SP4, this is applied to all of the times, and, as shown in Figure 5, only the portion containing angle θ_d is extracted from each cross-sectional image $C(d, t; \theta)$, and a new image is formed. This is called trace cross-sectional image $L(s, \theta; t)$, and it is found that this image becomes a place containing the velocity vector of the moving object. That is, this trace cross-sectional image $L(s, \theta; t)$ is an image obtained by cutting said time-space image $I(x, y; t)$ with a helix plane along the movement direction of the object. This plane completely contains the information pertaining to the movement of the object, that is, movement velocity and movement direction.

[0013]

Said application example explains the case when all of the consecutive images within a prescribed time are obtained beforehand. However, this is not a necessity. It is also possible to execute a series of operations for the consecutive images during an extremely short time, and setting the obtained results finally in time sequence to obtain the image corresponding to the trace cross-sectional images.

[0014]

Said application example explains the method in which the time-space image is simply cut by planes so as to obtain plural cut cross-sectional images. However, in order to better represent the movement trace of the object on the cross-sectional images, one may also adopt a scheme in which edge detection, noise removal, threshold treatment, other filter treatment, and similar characteristic quantity extracting treatment are performed on the original consecutive images beforehand to form a time-space image, and the results of the aforementioned treatment are projected on the plane instead of cutting with a plane, and images identical to the cross-sectional images can be obtained, and they can be used in forming the cross-sectional image.

[0015]

In said explanation, there is only one moving object. When there are plural moving objects in the cross-sectional images, plural groups of the cross-sectional images are prepared corresponding to the respective objects, to get the trace cross-sectional image for each object. In this way, the aforementioned procedure can be adopted as is when there are plural moving objects.

[0016]

Effects of the invention

As explained above, according to the present invention, it is alright that the movement direction of the moving body as the object is not known beforehand, and one may simply adopt an appropriate scheme in selecting the cutting plane. That is, cutting of the initial time-space image is performed in all directions. From the cutting results, the optimum cutting direction is known, and only its cutting plane is left. As a result, the cutting plane is made of a helix plane along the movement trace of the object, and this plane completely contains the movement vector of the object, and it contains all of the information about the movement trace. Consequently, the scheme for cutting the time-space image has the shared general properties, and the resistance to noise is improved.

Brief description of the figures

Figure 1 is a flow chart illustrating the flow of the overall treatment in an application example of the present invention.

Figure 2 is a diagram illustrating the state of the consecutive images and the moving body.

Figure 3 is a diagram illustrating the time-space image.

Figure 4 is a diagram illustrating the cross-section of the time-space image formed by a place parallel to the time axis.

Figure 5 is a diagram illustrating the method for forming the trace cross-sectional image from plural cross-sectional images.

Explanation of symbols

11, 12, 13	Consecutive images
21	Moving body
I	Time-space image
C	Cross-sectional image
L	Trace cross-sectional image

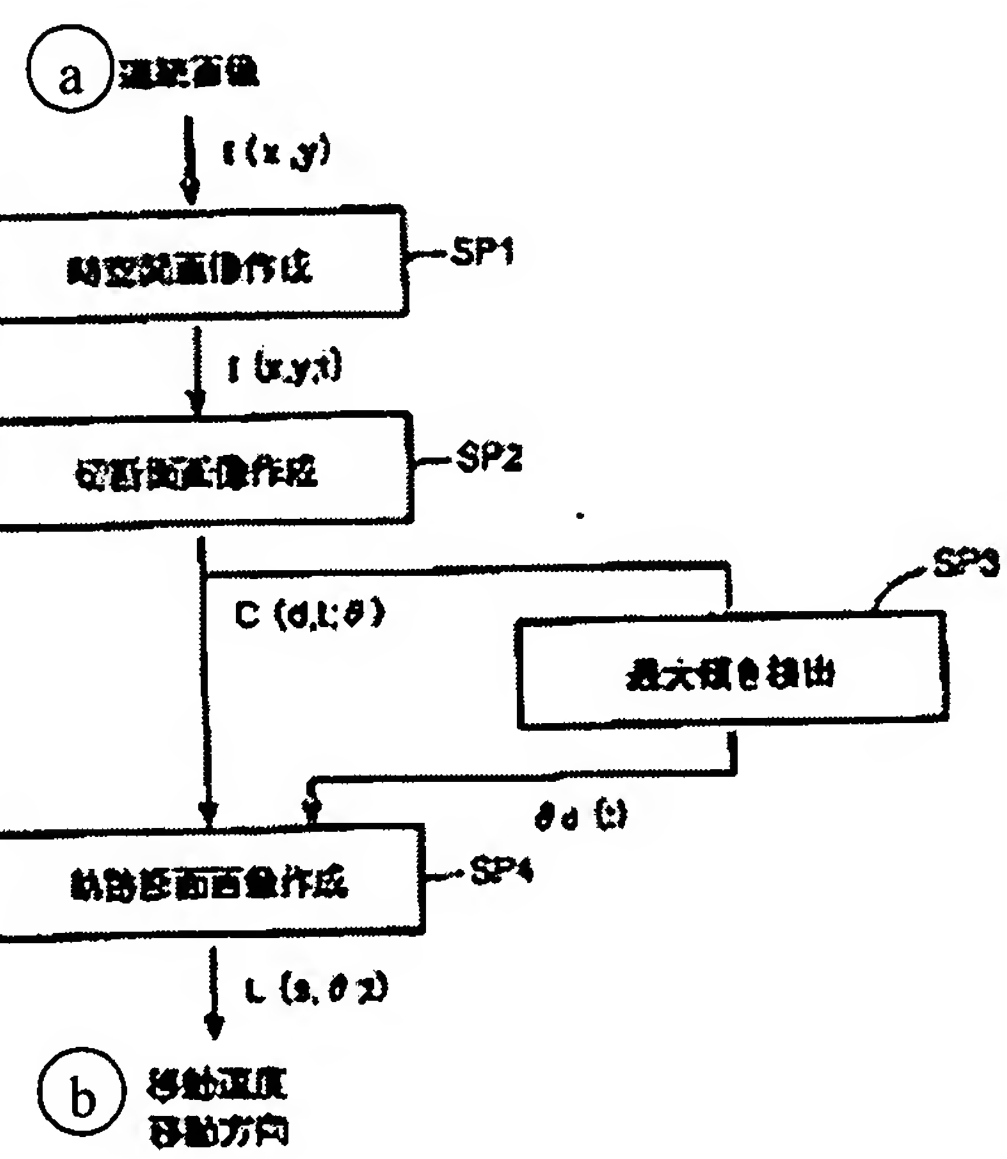

Figure 1

Key: a Consecutive images
b Movement velocity, movement direction
SP1 Formation of time-space image
SP2 Formation of cross-sectional image
SP3 Detection of maximum slope
SP4 Formation of trace cross-sectional image

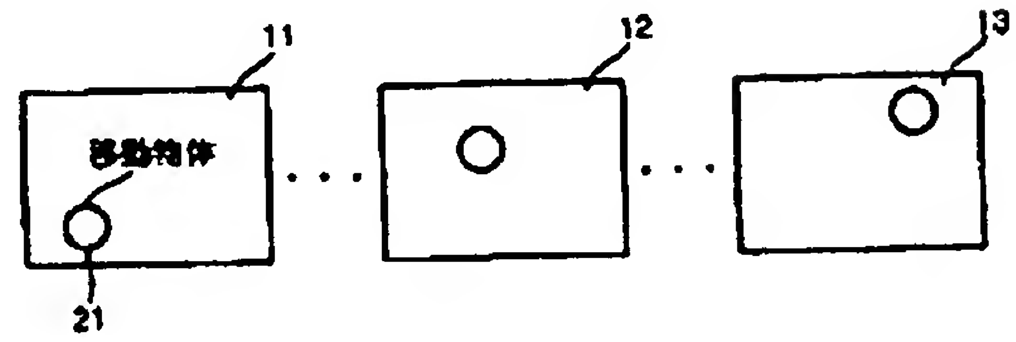

Figure 2

Key: 21 Moving body

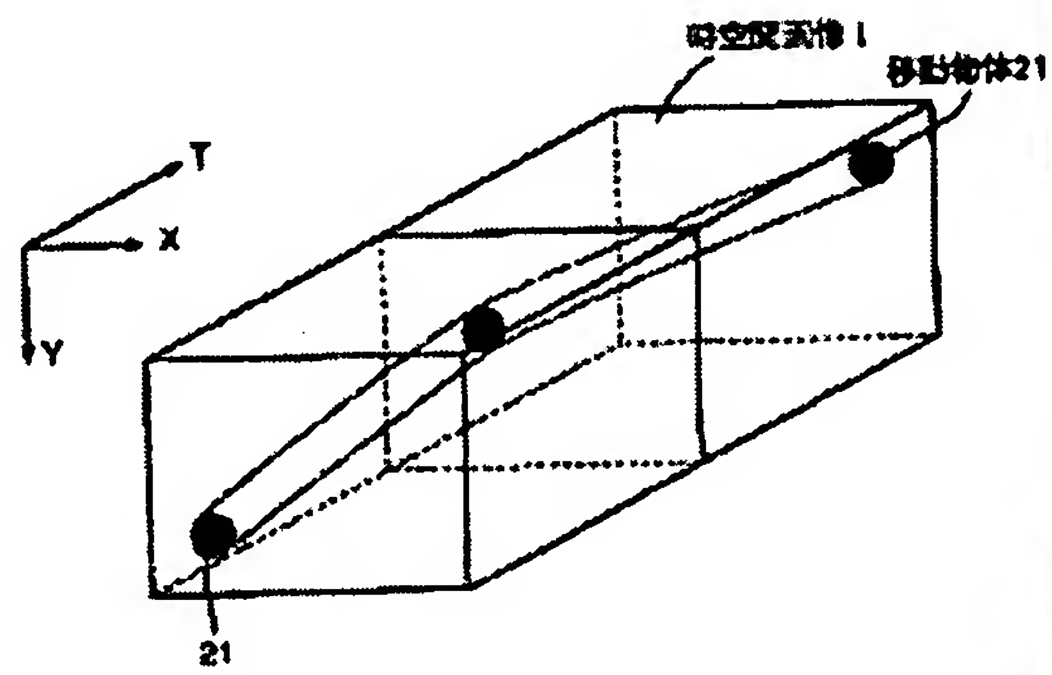

Figure 3

Key: I Time-space image
21 Moving body

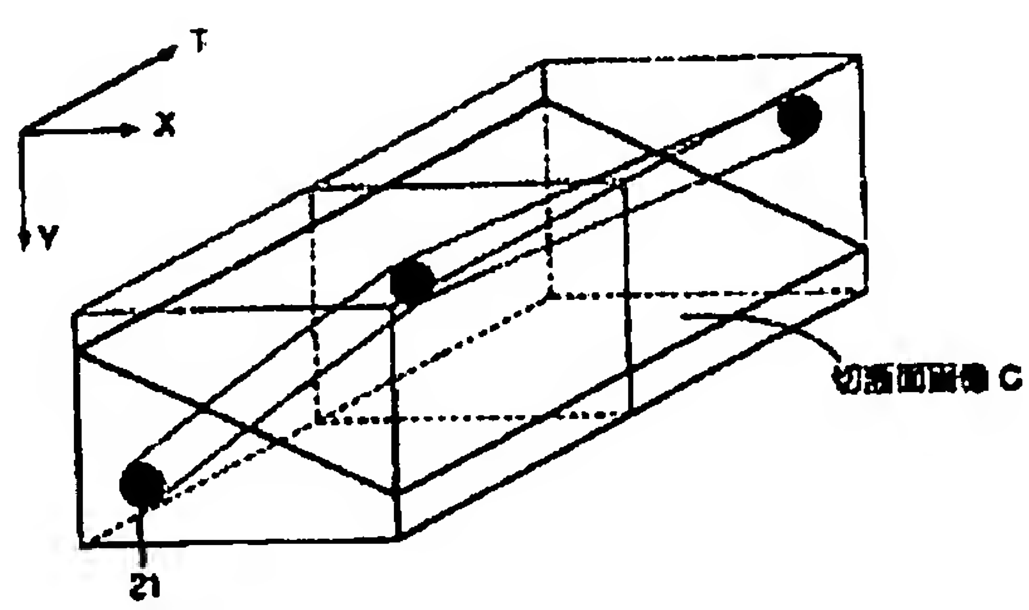

Figure 4

Key: C Cross-sectional image

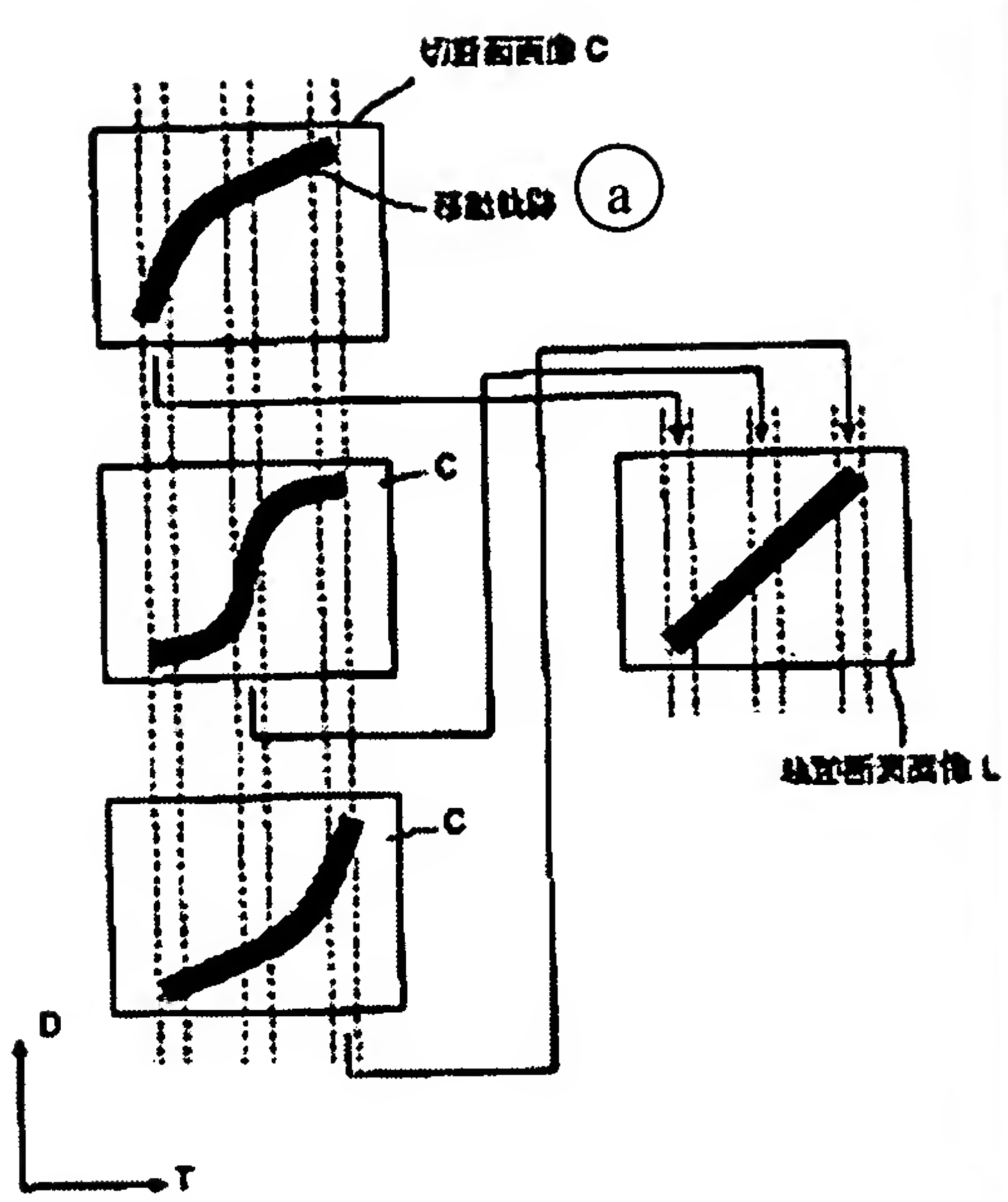

Figure 5

Key: a Movement trace
C Cross-sectional image
L Trace cross-sectional image